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Master

ADVANCED MATERIALS

Module Guide, Study Regulation and Curricula

Study regulation of 2010

Winter Semester 2011 / 2012

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Contents

MATERIALS SCIENCE I

Module allocated to 1st semester

Module Code	
Credit Points	10
Weekly Classroom Hours per Semester	8
Language of Instruction and Examinations	English
Duration of Module	1 semester
Cycle	Winter semester
Responsible for Module	Prof. Dr. Ulrich Herr
Lecturer	Prof. Dr. Ulrich Herr, lecturers of the Faculty of Engineering and Computer Science
Allocation of Module to Study Programmes	Master degree in Advanced Materials Compulsory
Prerequisites	BSc degree
Learning Outcomes	**Lecture:** Students will - understand the basics of materials science - be able to apply this knowledge to optimize materials properties, with a focus on mechanical properties. **Laboratory experiments:** Students will be able - to operate modern instruments - to applicate their fundamental knowledge of Materials Science - to present and report own experimental work/results
Course Contents	**Lecture:** - Crystal structures, defects and microstructure - Phase diagrams and phase transformations - Transport of atoms - Mechanical properties of materials **Laboratory experiments:** - X-ray diffraction (2 sessions) - Phase transformations - Atomic force microscopy - Microstructure (2 sessions) - Mechanical properties

Literature	- W.D. Callister: *Materials Science and Engineering - An Introduction* 6th ed., Wiley, London, 2003. - P. W. Atkins: *Physical Chemistry,* Oxford, 2010 *(*for chemical potential, thermodynamics of mixtures and thermodynamics of phase transformations) - M. Ohring: *Engineering Materials Science,* Academic Press, London, 1995. - M. F. Ashby, D. R. H. Jones: *Engineering Materials 1, 2nd ed.,* Butterworth-Heinemann, Oxford, 1996 - M. F. Ashby, D. R. H. Jones: *Engineering Materials 2, 2nd ed.* Butterworth-Heinemann, Oxford, 1998. - C. Barrett and T.B. Massalski: *Structure of Metals,* Pergamon, 1987
Teaching Methods	Materials Science I (L), 3 h/week Materials Science I (E), 1 h/week Lecture with demonstrations, exercises Lab Materials Science I (P), 2 h/week
Assessment of Work Load	56 h lecture and exercises (presence) 56 h preparation and revision of lecture 28 h lab and seminar (presence) 28h solution of exercises, revision 28 h preparation (laboratory) 88 h home writing report and revision, seminar talk preparation 16 h exam preparation **Total: 300 h**
Course Assessments and Examinations	Seminar, report, certificate written examination of 120 min., precondition: successful participation in exercises
Grading	Result of the written exam with the weight of the whole module
Usability	Materials Science II, Nanomaterials I and II, Biomaterials I and II

MATERIALS SCIENCE II

Module allocated to 2nd semester

Module Code	
Credit Points	10
Weekly Classroom Hours per Semester	8
Language of Instruction and Examinations	English
Duration of Module	1 semester
Cycle	Summer semester
Responsible for Module	Prof. Ulrich Herr
Lecturer	Prof. Ulrich Herr, lecturers of the Faculty of Engineering and Computer Science
Allocation of Module to Study Programmes	Master degree in Advanced Materials Compulsory
Prerequisites	- Materials Science I, Introductory Solid State Physics, Physical Chemistry
Learning Outcomes	**Lecture** Students will be able to describe the process of fatigue and the basic causes of fatigue failure - classify metallic, ceramic and polymeric materials based on atomic-level structures, characteristic microstructures and macroscopic properties - understand and interpret the influence of materials processing on the microstructure and properties of metallic alloys, ceramics and polymers - relate the structure of a composite material to improvements in strength and toughness - understand the physical basis for the observed thermal, electrical and magnetic properties of solid materials select appropriate materials and processing routes for the realization of engineering design goals, based on property and performance characteristics **Laboratory experiments** Students will learn to - operate modern instruments - applicate their fundamental knowledge of Materials Science - be able to present and report own experimental work/results
Course Contents	**Lecture** The concepts of materials science are applied to a variety of materials types, including both conventional and novel classes of materials. Topics include materials processing and optimization, heat treatment, structure-property relationships and the stability of micro- and nanostructure. Syllabus: - Selected metallic alloys - Ceramics and glass - Polymers - Electrical Properties - Semiconductors

	- Magnetic Properties - Optical properties - Nanostructured Materials **Laboratory experiments:** - Lambda probe - Optical properties of ceramics - Kerr magnetometry and microscopy - Thin film preparation - Elastic properties - Hydrogen storage
Literature	- W. D. Callister: *Materials Science and Engineering: An Introduction,* 6th ed., Wiley, London, 2003. - M. Ohring: *Engineering Materials Science* Academic Press, London, 1995. - M. F. Ashby, D. R. H. Jones: *Engineering Materials 1, 2nd ed.* Butterworth-Heinemann, Oxford, 1996 - M. F. Ashby, D. R. H. Jones: *Engineering Materials 2, 2nd ed.* Butterworth-Heinemann, Oxford, 1998.
Teaching Methods	Materials Science II (L), 3 h/week Materials Science II (E), 1 h/week lecture with demonstrations, exercises Lab Materials Science II, (P), 2h/week
Assessment of Work Load	52 h lecture and exercises (presence) 52 h preparation and revision of lecture 26 h lab and seminar (presence) 26 h solution of exercises, revision 26 h preparation (laboratory) 102 h home writing report and revision, seminar talk preparation 16 h exam and preparation of lecture **Total: 300 h**
Course Assessments and Examinations	Seminar, report, certificate Written examination of 120 min. Prerequisite: Successful participation in the exercises
Grading	Result of the written exam with the weight of the whole module
Usability	Precondition for: Nanomaterials II, Biomaterials II

CHEMISTRY

Module allocated to 1st and 2nd semester

Module Code	
Credit Points	11
Weekly Classroom Hours per Semester	8
Language of Instruction and Examinations	English
Duration of Module	2 semester
Cycle	Winter and summer semester
Responsible for Module	NN
Lecturer	Lecturers of Institutes of Chemistry
Allocation of Module to Study Programmes	Master degree in Advanced Materials Compulsory
Prerequisites	BSc degree
Learning Outcomes	The students will learn and understand - the fundamentals of general chemistry and chemical synthesis with respect to the preparation of organic polymeric and inorganic materials - the principles of quantum chemistry - practical aspects of thermodynamics - basics of reaction kinetics - fundamental principles of modern solid state chemistry like structures, properties, syntheses and applications of solid materials
Course Contents	**Inorganic Chemistry:** Atoms, Hydrogen, Halogens, Chalcogens **Structure Formation** *Interactions:* Van der Waals, interaction forces, electrostatic interaction between systems **Physical Chemistry:** *Quantum Chemistry:* Some simple systems, postulates and Schrödinger equation, atomic structure and qualitative molecular orbital theory. Practical Aspects of the Laws of Thermodynamics, Boltzmann and Fermi-Dirac statistics *Reaction kinetics and catalysis:* Concept of activation energy, interfaces, electrocatalysis, application on fuel cells *Fundamental concepts of spectroscopy and photochemistry: C*orrelation between molecular structures and spectra, principle of Laser, applications for solar cells. **Solid State Chemistry:** Structure of solids, basic crystallography, characterization of solids Bonding in solids, Real structure of crystals Solid state reaction, sol-gel method, hydrothermal synthesis, vapor phase transport, methods for crystal growth, structure-property relations

Literature	- Charles E. Mortimer: *Chemistry: A Conceptual Approach,* Brooks Cole, 6th ed. 1986. - L. Jones, P. Atkins, *Chemistry – Molecules, Matter, and Change*, W. H. Freeman, New York, chapter 11. 2002 - J. M. G. Cowie V. Arrighi, *Polymers: Chemistry and Physics of Modern Materials*, Taylor and Francis, 2008 - H.-G. Elias: *An Introduction to Polymer Science,* VCH Weinheim 1997, chapters 1-4. - John R. Dean: *Practical Skills in Chemistry*, Prentice Hall 2002. - Peter Atkins, Julio de Paula, "Physical Chemistry", 2010 - A.R. West, Solid State Chemistry and its Applications, Wiley, 1989 - L. Smart, Moore Elaine A, Solid State Chemistry, An Introduction CRC, 2005 - http://www.chemistry.ohio-state.edu/~woodward/ch754...
Teaching Methods	Organic Materials and Structure Formation (L), 4 h/week Physical Chemistry (L), 3 h/week Solid State Chemistry(L), 1 h/week
Assessment of Work Load	112 h lecture and exercises (presence) 170 h preparation, revision lecture, solution of problems 48 h exam preparation **Total: 330 h**
Course Assessments and Examinations	Written examination Prerequisite: Successful participation in the exercises of Physical Chemistry
Grading	Result of the written exam with the weight of the whole module
Usability	Precondition for: Nanomaterials I and II, Biomaterials I and II

PHYSICS

Module assigned to 1st and 2nd semester

Module Code	
Credit Points	9
Weekly Classroom Hours per Semester	8
Language of Instruction and Examinations	English
Duration of Module	2 semester
Cycle	winter term
Responsible for Module	Prof. Dr. Paul Ziemann
Further Lecturer	Dr. Ulf Wiedwald
Allocation of Module to Study Programmes	Master degree in Advanced Materials Compulsory
Prerequisites	Basic knowledge of Physics including an introduction into Quantum Mechanics & Mathematics according to a BSc degree
Learning Outcomes	**Module** aims at providing the basic knowledge as well as some fundamental practical tools of Solid State Physics necessary to understand all the forthcoming more advanced Materials Science courses. **Lecture:** The students will gain insight into the close relation between structural & physical properties. They will be able to classify materials according to their structure, underlying bonding and materials properties. The students also will be able to name phenomena & materials properties which are caused or strongly influenced by lattice vibrations. In addition to the classical description of these vibrations, they will be aware of and can describe the concept of quantized vibrations in terms of phonons as bosonic excitations of a Solid. Similary, the students will gain insight into basic electronic solid state systems and realize the fundamental difference between fermionic and bosonic behavior. In this way, they will develop an awareness as to why classical physic mostly fails to predict materials properties and quantum effects have to be included for that purpose. Finally, based mainly on the knowledge of electronic systems, optical properties of dielectrics and metals as well as the magnetic behavior of materials are discussed enabling the students to make at least qualitative predictions of such properties from simplified assumptions on the electronic system of a material. **Laboratory:** In close temporal correlation to the contents of the lecture, the Lab course aims at providing practical support to the more abstract concepts introduced in the lecture as well as “hands-on” experience how to experimentally determine basic solid state properties. The gained practical expertise will enable the students to perform X-ray structure analysis on simple metals using state of-the-art equipment. Similarly, they will be able to apply XPS to analyze electronic core levels of various elements, while the measurement of electric conductivity will teach them the use of cryostats down to temperatures of 77 K.

	Besides the practical training in using various research equipment, the Lab will transfer knowledge how to design and organize advanced experiments in Solid State Physics as well as how to write a scientific report. Both abilities will help them to successfully tackle the task of delivering an experimental Master thesis.
Module Contents	**Lecture:** a) Basic Classification of Solids by Structure & Bonds & Properties b) Experimental Structure Determination b) Lattice Vibrations & Phonons c) Electronic properties of Solids, Free Electron Models d) Optical properties of Solids e) Magnetic properties of Solids **Laboratory:** I) Specific heat of simple metals between 2 K and 20 K II) Advanced measurement techniques: Application of a Lock-in amplifier III) Electrical conductivity of metals and semiconductors between 2K and 70 K IV) XPS on Au and Au_2O_3 V) Optical properties of Au films and Au nanoparticles
Literature	- Introductory Solid State Physics by H. P. Myers, Taylor & Francis, London 1997 - Introduction to Solid State Physics by Ch. Kittel, John Wiley & Sons 2005 (International Edition) - Solid-State Physics by H. Ibach, H. Lüth, Springer, Berlin 2003 - Handouts related to specific problems are distributed in the lectures
Teaching Methods	Solid State Physics (L), 3 h/week Solid State Physics (E), 1 h/week Solid State Physics (P), 1 h/week
Estimation of working load	56 h lecture and 18 h laboratory (presence), 50 h preparation and postprocessing lecture 28 h solution of exercises, postprocessing 22 h preparation for laboratory 80 h home writing laboratory report and revision 16 h exam preparation **Total: 270 h**
Examinations	written examination, non-valuated successful participation in the Lab course including a colloquium and a written report for each experiment
Grade Composition	Result of the written exam with the weight of the whole module
Usability	MSc course of studies Advanced Materials, precondition for Advanced Physics, Nanomaterials I and II, Biomaterials I and II

ENGINEERING

Module allocated to 1st semester

Module Code	
Credit Points	5
Weekly Classroom Hours per Semester	4
Language of Instruction and Examinations	English
Duration of Module	1 semester
Cycle	winter semester
Responsible for Module	Prof. Dr. Ferdinand Scholz
Lecturer	Prof. Dr. Ferdinand Scholz
Allocation of Module to Study Programmes	Master degree in Advanced Materials Compulsory for students with major subject Nanomaterials Elective for students with major subject Biomaterials
Prerequisites	BSc degree
Learning Outcomes	Students should be able to - perform circuit analysis of linear DC and AC (RLC) circuits - analyze transient problems of RLC circuits - understand the basics of crystal and semiconductor physics - understand how basic semiconductor devices work - understand basic treatment/evaluation of measured data - understand conversion of analogue data into digital data, basic treatment of digital data, advantages and problems of digital data processing
Course Contents	- *Circuit analysis:* network analysis, voltage and current dividers, duality, node-voltage analysis, mesh current analysis, Thevenin and Norton equivalent circuits, superposition principle, linearity, Wheatstone bridge; Capacitors & inductors, ideal and real transformers, - *Analysis of transients:* First and second order transient circuits, steady-state sinusoidal analysis, frequency analysis, filters, frequency response, - *Semiconductors*: Carrier statistics, density of states, Fermi statistics, impurity conduction, mobility, diffusion, Hall effect - *Diodes:* p-n-junction, ideality factor, load line analysis, fabrication, special diodes, pn as capacitance, hetero junction, Schottky diode, compound semiconductors - *Transistors:* Bipolar transistor, band structure, common base, common emitter, amplification, Field Effect Transistor: Structure, operation, enhancement and depletion; load line analysis - *Devices for measurement:* Operational amplifier: Basics, adder, subtractor, integrator, differentiator, logarithmiser, instrumentation amplifier

	- *Signal filtering, Noise :* Thermal, shot, 1/f, distribution, generation-recombination, noise figure of 4-port, Signal filtering: passive, active, Lock-In, Boxcar, signal transmission - *Digital Signal Processing:* Gray code, basic logic operations, adders, flip-flop, Digitization: Basics, sampling theorem, DA and AD converters, Digital filters, z-transformation, Microcomputers, microcontrollers: Building blocks, data storage
Literature	- Allan R. Hambley: *Electrical Engineering*, Prentice Hall, Upper Saddle River, 2002. - Ch. Kittel, *Introduction to Solid State Physics*, Wiley, New York, 1996. - H.P. Hsu. *Schaum's Outlines: Signals and Systems*, McGraw-Hill, New York, 1995. - S.M. Sze, *Physics of Semiconductor Devices*, John Wiley & sons, New York, 1981. - P. Profos and T. Pfeifer, *Handbuch der industriellen Messtechnik*, R. Oldenbourg, München, 1994.
Teaching Methods	Introductory Engineering (L), 3 h/week Introductory Engineering (E), 1 h/week
Assessment of Work Load	42 h lecture (presence) 14 h exercises, practical training (presence) 50 h preparation and revision lecture 28 h solution of exercises, revision 16 h exam preparation **Total: 150 h**
Examinations	written examination precondition: Successful participation in exercises
Grading	Result of the written exam with the weight of the whole module
Usability	Materials Science II, Nanomaterials I and II, Biomaterials I and II, some Electives

BIOLOGY

Module allocated to 1st semester

Module Code	2288870 LSF-QISPOS: 10866
Credit Points	5
Weekly Classroom Hours per Semester	4
Language of Instruction and Examinations	English
Duration of Module	1 semester
Cycle	winter semester
Responsible Lecturer	Prof. Dr. Bernhard Koch
Lecturers	Prof. Dr. Bernhard Koch, Prof. Dr. Paul Walther, PD Dr. Andreas Ziegler
Allocation of Module to Study Programmes	Master degree in Advanced Materials Compulsory for students with major subject Biomaterials Elective for students with major subject Nanomaterials
Prerequisites	BSc degree
Learning Outcomes	The students will - be able to understand central problems of Biology and Cell Biology. Be able to understand links between fields of Biosciences - be well prepared to for lectures in Biomaterials in 2nd and 3rd semester
Course Contents	BASICS AND ECOSYSTEMS Secondary production in ecosystems The cycling of chemical elements in ecosystems BIOMOLECULES Water and the fitness of the environment Carbon and the molecular diversity of life Major classes of biomolecules Structure and function of macromolecules Introduction to metabolism, Enzymes CELLULAR RESPIRATION Harvesting chemical energy CELL MORPHOLOGY AND GENEXPRESSION A tour of the cell Membrane structure and function The cell cycle The molecular basis of inheritance From gene to protein Regulation of genexpression ORGANISMIC AND ANIMAL DIVERSITY The major lineages of life Prokaryotes and the origins of metabolic diversity The origin and early diversification of eukaryote details from animal evolution and groups of invertebrates DEVELOPMENT Animal development Development genes and their detection FUNCTIONAL ANATOMY An introduction to animal structure and function muscle function Nervous system

	ENDOCRINOLOGY Chemical signals in animals Blood glucose and adrenal gland Hormones in non-vertebrates CIRCULATION AND GAS EXCHANGE Circulation and gas exchange Gas exchange in animals INTRACELLULAR COMPARTMENTS AND PROTEIN SORTING Vesicular Transport Cytoskeleton and Mitosis STRUCTURE AND FUNCTION OF CELLULAR MEMBRANES Cell-cell contacts and cell adhesion Structure and function of the extracellular matrix
Literature	- N. A. Campbell, J. B. Reece: BIOLOGY, Benjamin Cummings Publisher, 6th edition (2002) - Thomas D. Pollard, William C. Earnshaw , Jennifer Lippincott-Schwartz, CELL BIOLOGY, Saunders (2007) - Handouts related to specific problems are distributed in the lectures
Teaching Methods	Introductory Biology and Cell Biology (L), 4 h/week
Assessment of Work Load	60 h lecture (presence) 74 h preparation and revision lecture 16 h exam preparation **Total: 150 h**
Examinations	written examination of 120 min
Grading	Result of the written exam with the weight of the whole module
Usability	MSc course of studies Advanced Materials Biomaterials I and II, some Electives

NANOMATERIALS I

Module allocated to 2nd semester

Module Code	
Credit Points	8
Weekly Classroom Hours per Semester	6
Language of Instruction and Examinations	English
Duration of Module	1 semester
Cycle	Winter and summer semester
Responsible for Module	Prof. Paul Ziemann
Lecturers	Prof. PhD Carl Emil Krill, Prof. Dr.-Ing. Ulrich Herr, Dr. U. Simon
Allocation of Module to Study Programmes	Master degree in Advanced Materials Compulsory for major Nanomaterials
Prerequisites	Materials Science I and II, Solid state Physics
Learning Outcomes	**Advanced Physics:** Students will - be able to explain how translational symmetry leads to electronic band structures and to derive related consequences on materials properties. They also will be able to link macroscopic optical materials properties to microscopic models. In magnetism they will learn about different types of materials and phenomena as well as the basic ideas to explain them microscopically. **Computational Methods in Materials Science:** - learn the most important computational methods in Materials Science - be familiar to these methods by practical training.
Module Contents	**Advanced Physics:** Emphasis is put on effects based on band structure, optical as well as magnetic properties. - From free electrons to nearly free electrons: About bands & gaps- Fermi surfaces - - Quasi-classical description of electron dynamics, effective mass, electrons & holes, - Metals vs. semiconductors/insulators: Effects of doping - Optics of metals, plasmons - Magnetism: Curie law, Hund's rule, Pauli susceptibility, ferromagnetic phenomena & descriptions **Computational Methods in Materials Science:** - What is a model? - Modeling in materials science - Simulation vs. modeling - Numerical solution of differential equations using methods of Statistical mechanics Monte Carlo methods Molecular dynamics Phase-field models Finite element (FE) method

Literature	- General literature on Solid State Physics as given for Introductory Solid State Physics (1.Sem.). Additionally: - *Introduction to Magnetic Materials* by B. D. Cullity, C. D. Graham, Wiley & Sons and IEEE Press 2009 - Handouts related to specific problems are distributed in the lectures - M.M. Wolfson, G.J. Pert: *An Introduction to Computer Simulation* (Oxford, 1999) - D. Raabe: *Computational Materials* Science (Wiley-VCH, 1998) - S.E. Koonin, D.C. Meredith: *Computational Physics* (Addison-Wesley, 1990) - D.C. Rapaport: *The Art of Molecular Dynamics Simulation* (Cambridge, 2004)
Teaching Methods	Advanced Physics (L), 2 h/week Advanced Physics (E), 1 h/week Computational Methods in Materials Science (L), 2 h/week Practical exercises (P) 1 h/week
Assessment of Work Load	56 h lecture (presence) 28 h exercises (presence) 68 h preparation and revision lecture 56 h solution of exercises, revision 32 h exam preparation **Total: 240 h**
Course Assessments and Examinations	written examination precondition: successful participation in exercises
Grading	exam result
Usability	Nanomaterials II, Master Thesis,MSc course of studies Advanced Materials

NANOMATERIALS II

Module allocated to 3rd semester

Module Code	
Credit Points	13
Weekly Classroom Hours per Semester	9
Language of Instruction and Examinations	English
Duration of Module	1 semester
Cycle	winter semester
Responsible for Module	Prof. Dr. Jürgen Behm
Lecturer	Prof. Dr. Peter Unger, Prof. Dr. Jürgen Behm, Prof. Dr. Bernardt, PD Dr. Bansmann, PD Dr. Ulrich Ziener
Allocation of Module to Study Programmes	Master degree in Advanced Materials Compulsory for students with major subject Nanomaterials Elective for students with major subject Biomaterials
Prerequisites	Nanomaterials I
Learning Outcomes	This module on Nanomaterials provides an advanced understanding of the technology for fabricating structures with micron- and nanometer-scale dimensions. Students will gain an insight into a) the basics and production of functional nanomaterials b) the structure-function relationship at the nanoscale which enables new routes to the knowledge based design of functional nano-materials In the first part (*Micro- and Nanotechnology, Principles of structure formation in nanomaterials I & II*), the module aims at introducing state of the art approaches of how to prepare and characterize various nanostructures. The students will be able to address various approaches according to their advantages or disadvantages, their limits, costs and applicability for industrial production. The second part (*Functional Properties of Nanomaterials*) focuses on physical properties like electronic, optic and magnetic properties of nanostructures which are due to their dimensional constraints. The students will gain insight as to how the nanoscale can induce novel materials properties.
Course Contents	***Micro- and Nanotechnology:*** At the beginning of the course, the basic technological processes for lithography and pattern transfer techniques are discussed. As applications of these technologies, fabrication processes are presented like CMOS and III-V technology, micromechanics, magnetic thin-film heads, flat-panel displays, micro optics, x-ray optics and quantum-effect electronic devices. The lectures are accompanied by exercises, where important original publications will be discussed and hands-on experiments in the clean room will be performed. **Polymeric Materials** *Polymeric Materials:* Block copolymers, liquid-crystalline polymers, semiconducting and conducting polymers, nanolithography with polymers, molecular imprinting

	Principles of Structure Formation *Surface Structuring and Nanoparticles:* Classes of chemical reactions/processes, growth modes in growth processes, elementary surface processes during film growth, *Applications of nanoparticles:* Their use in heterogeneous catalysis, basic types of bimolecular catalytic reactions *Cluster Based Materials:* Chemisorption (dissociative or molecular) and molecular physisorption. Clusterstructure calculations based on the Lennard-Jones (LJ) interaction potential, cluster mass spectra, Carbon cluster structures, one-dimensional metal structures **Functional Properties of Nanomaterials** Nanoscience: What is it all about? Examples, approaches, A. Analytical Tools in Nanoscience B. Preparations & Properties of Nanostructures 1. Electronic & Optical Properties 2. Magnetic Properties
Literature	- Marc J. Madou: *Fundamentals of Microfabrication, 2nd edition* CRC Press, Bota Raton, 2002. - Henry I. Smith: *Submicron- and nanometer-structures technology, 2nd edition,* NanoStructures Press, 437 Peakham Road, Sudbury, MA 01776, USA, 1994. - L.F. Thompson, C.G. Willson, and M.J. Bowden: *Introduction to Microlithography, 2nd edition* ACS Professional Reference Book, American Chemical Society, 1994. - D.V. Morgan and K. Board: *An introduction to semiconductor microtechnology, 2nd edition* John Wiley & Sons, Chichester 1994. - S.M. Sze: *Semiconductor devices - Physics and technology* John Wiley & Sons, New York 1985. - Geoffrey A Ozin, André C Arsenault, Ludovico Cademartiri, *Nanochemistry* Cambridge : RSC Publ. , 2005 - Butt, Hans-Jürgen; Graf, Karlheiz; Kappl Michael, *Physics and Chemistry of Interfaces*, Second Edition, Weinheim : Wiley-VCH , 2006 - Bhushan B., *Springer Handbook of Nanotechnology*, Berlin, Heidelberg : Springer Science+Business Media, Inc , 2007 Köhler Michael und Fritzsche Wolfgang, Nanotechnology, Weinheim : Wiley-VCH , 2007
Teaching Methods	Micro- and Nanotechnology (L), 2 h/week, (E), 1 h/week Polymeric Materials (L), 2 h/week Principles of structure formation in nanomaterials (L), 2 h/week Functional Properties of Nanomaterials (L), 2 h/week
Assessment of Work Load	88 h lecture (presence) 14 h exercises, practical training (presence) 34 h preparation and revision lecture 28 h solution of exercises, revision 16 h exam preparation **Total: 390 h**
Examinations	Written or oral examinations, precondition: successful participation in exercises
Grading	Exam result

BIOMATERIALS I

Module allocated to 2nd semester

Module Code	
Credit Points	5
Weekly Classroom Hours per Semester	4
Language of Instruction and Examinations	English
Duration of Module	1 semester
Cycle	summer semester
Responsible for Module	Prof. Dr. Anita Ignatius
Lecturers	Lecturers of the Faculties of Medicine and Natural Science
Allocation of Module to Study Programmes	Master degree in Advanced Materials Compulsory for students with major subject Biomaterials Elective for students with major subject Nanomaterials
Prerequisites	Biology and Cell Biology
Learning Outcomes	Biomaterials are synthetic or natural materials, which are applied to replace or support tissue or organs. To understand the demands for biomaterial development it is important to know the characteristics of tissues to be replaced. All of them having specific characteristics and properties. There is a broad field of different applications in e.g. dental medicine, orthopaedic and trauma surgery, cardiovascular surgery, ophthalmology, or plastic surgery. The students will learn and be able to understand - composition, structure, properties and function of biological tissues/organs which are often replaced or supported by biomaterials - clinical problems making biomaterials application necessary - chemical composition and properties of different material classes which are used in biomaterial applications - processing of biomaterials - biological and mechanical properties of materials - advantages and disadvantages of materials - the application of biomaterials and implants in various tissues which have to be replaced or supported - the positive aspects of materials and implants and the risks in their application
Course Contents	**Biological Tissue** 1) Cartilage 2) Tendon, ligament 3) Blood vessels, heart 4) Eyes 5) Bone 6) Teeth 7) Blood 8) Kidney 9) Liver/ pancreas 10) Skin **Classes of Biomaterials** 1) Polymers 2) Hydrogels 3) Metals 4) Natural Materials 5) Composites 6) Ceramics **Applications of Biomaterials** 1) Materials for Drug-Delivery 2) Artificial Liver and Pancreas 3) Materials for bone replacement 4) Materials for Tooth Repair 5) Blood, Vessels Replacement 6) Eyes, Eye implants 7) Bone, Cartilage and Ligament Replacement

	8) Skin Replacement 9) Joint replacement
Literature	- Hunt, Janie Yungblut L., *"Soft and Hard Tissue Repair: Biological and Clinical Aspects"* Arch Surg. 1984;119(12):1439. - Silver F.H.: Biomaterials, *Medical devices and tissue engineering,* Chapman & Hall , 1994 - Ratner B.D. / Hoffmann A.S. / Schoen F. J. / Lemons J.E. (eds.): An *Introduction to materials in medicine*, Elsevier, 2004 - Temenoff, Johnna S., Mikos, Antonios G., Temenoff, J. S., "*Biomaterials: The Intersection of Biology and Materials Science*", Prentice Hall, 2009 - Lakes, R. S., Park, Joon*:"Biomaterials",* Springer Verlag, New York *, 2007* - Bidanda, Bopaya / Bartolo, Paulo (eds.) *"Bio-Materials and Prototyping Applications in Medicine", Springer Verlag, New York, 2007* - Park, Joon B., Bronzino, Joseph D., Park, Park B. *"Biomaterials: Principles and Applications" , CRC Press, 2003*
Teaching Methods	Biomaterials I (Biological Tissues, Classes and Aplications of Biomaterials) (L), 4 h/week
Assessment of Work Load	56 h lecture (presence) 78 h preparation and revision lecture 16 h exam preparation and exam **Total:** 150 h
Examinations	Written examination
Grading	Result of the written exam with the weight of the whole module
Usability	MSc course of studies Advanced Materials, Biomaterials II, some electives

BIOMATERIALS II

Module allocated to 2nd and 3rd semester

Module Code	2288870300 LSF-QISPOS: 11340
Credit Points	8
Weekly Classroom Hours per Semester	7
Language of Instruction and Examinations	english
Duration of Module	2 semester
Cycle	summer and winter semester
Responsible for Module	Prof. Dr. Anita Ignatius
Lecturer	Lecturers of the Faculties of Medicine and Natural Science
Allocation of Module to Study Programmes	Master degree in Advanced Materials Compulsory for students with major subject Biomaterials Elective for students with major subject Nanomaterials
Prerequisites	Biomaterials I
Learning Outcomes	a) Biomaterials are not stable but degrade or corrode in the body. This could lead to changes in the chemical composition and in the biological and mechanical properties. Students will know and understand - the desired or undesired degradation of biomaterials in a biological environment with special focus of the chemical and biological degradation of polymers and corrosion of metals as well as the mechanical breakdown - the problems connected with materials degradation. Degradation is analyzed in detail, from both negative and positive aspects. b) Biomaterials interact with the biological environment leading to at best to integration or to inflammation and foreign body reactions. Students will learn and understand - the host reactions and the relationships between synthetic biomaterials and the biological environment - know the positive interactions leading to the integration of materials into the tissue - the negative interactions leading to inflammatory reactions, foreign body reactions and implant loosening c) Biomaterials used for medical devices must be thoroughly tested before their introduction so that any negative effects on the body are known and can be prevented. By using in vitro laboratory tests, dangers for patients and unnecessary animal experiments can be avoided. Students will know - appropriate test methods used in vitro and in vivo - the regulatory standards for approval of biomaterials d) The students will gain knowledge of properties, processing and usage of biocompatible materials during the visits in different companies. e) Students will get an expertise in working with biomaterials together with experienced researchers
Course Contents	**Degradation of Biomaterials** 1) Corrosions of metals 2) Degradation of Polymers **Host Reactions to Biomaterials** 1) Blood reactions to biomaterials

	2) In vitro cell-biomaterials reactions 3) In vivo tissue reactions to biomaterials 4) Systemic effects of biomaterials **Biomechanical Testing of Biomaterials** 1) In vivo testing of biomaterials 2) In vitro testing of biomaterials **Commercial Production of Biomaterials** Whole day excursions to different companies, where different labs, processing halls and plants are visited. Often combination with an additional lecture. **Lab Biomaterials** Experimental work in an institute in agreement with the head of institute
Literature	- Buddy D. Ratner, Allan S. Hoffman, Frederick J. Schoen *"Biomaterials Science, An Introduction to Materials in Medicine"*, Academic Press, 2004 - Handouts
Teaching Methods	Biomaterials II (L), 2 h/week Biomaterials II (excursions) 1 h/week Biomaterials II (lab) 4h/week
Assessment of Work Load	28 h lecture (presence) 48 h preparation and revision lecture 16 h exam preparation 54 h excursion inclusive preparation and revision 80 h laboratory (presence) 16 h report and seminar **Total: 240 h**
Examinations	Seminar, report, excursion, certificates written examination of 120 min., precondition: successful participation in all excursions and successful attendance in a lab course
Grading	Result of the written exam with the weight of the whole module
Usability	Master Thesis, MSc course of studies Advanced Materials

ELECTIVES

Module allocated to first three semesters

Module Code	
Credit Points	at least 16 CPs for students with major “Nanomaterials” at least 24 CPs for students with major “Biomaterials”
Weekly Classroom Hours per Semester	Various
Language of Instruction and Examinations	English
Duration of Module	3 semester
Cycle	Winter and summer semester
Responsible for Module	Prof. Paul Ziemann
Lecturers	Lecturers of all faculties of Ulm University and external lecturers
Allocation of Module to Study Programmes	Master degree in Advanced Materials
Prerequisites	Successful participation of 1st semesters compulsory courses
Learning Outcomes	Depending on the students’ choice, the module provides in-depth courses in the fields of *nanomaterials* or *biomaterials*, respectively. Despite of the specific choice of specialization, due to overlapping lectures, students still have the chance to gain insights complementary to their primary subject. Within their chosen specialization, students will obtain the necessary theoretical understanding as well as the knowledge of state-of-the-art experimental tools to start their experimentally oriented master theses.
Module Contents	For both possible specializations – *nanomaterials* and *biomaterials* – the elective lectures are categorized according to: • Preparational-oriented • Analytical-oriented • Property-oriented complemented by lectures on project planning and managing. Detailed contents are given for each lecture in a accompanying brochure edited semester by semester.
Literature	Detailed information on literature is given for each lecture in an accompanying brochure edited semester by semester.
Teaching Methods	Lectures, seminars, exercises
Assessment of Work Load	Depending on the courses
Course Assessments and Examinations	written examination, oral examinations, presentations precondition: successful participation in exercises
Grading	exam result, result of presentations
Usability	MSc course of studies Advanced Materials

ASQ – Key Qualifications

(**A**dditive **S**chlüssel **Q**ualifikationen)

Module allocated to first three semesters

Module Code	
Credit Points	8
Weekly Classroom Hours per Semester	Depending on courses
Language of Instruction and Examinations	Depending on courses
Duration of Module	3 semester
Cycle	Winter and summer semester
Responsible for Module	Prof. Paul Ziemann
Lecturers	Lecturers of Language Center, Humboldt Center, all faculties of Ulm University, external lecturers
Allocation of Module to Study Programmes	Master degree in Advanced Materials Compulsory for major Nanomaterials
Prerequisites	Admission to Advanced Materials
Learning Outcomes	Students will acquire and/or improve their knowledge of foreign languages. For Non-German students the „German Language“ courses are mandatory enabling them to handle every-day-situations in German. German students have the choice between various foreign language courses offered by the University’s Language Center. Additionally, the ASQ Module will enhance the intercultural competence of all students as well as improve their abilities - to work in a team, - to orally communicate and present a specific scientific or non-scientific topic - to search literature related to a specific scientific topic - to plan and write a scientific report - to participate in project management to understand patent regulations
Module Contents	Courses vary from semester to semester and corresponding details are given in the special program brochures edited each semester by the University’s Language and Humboldt Center
Literature	See special brochures edited by the University’s Language and Humboldt Center
Teaching Methods	Lectures, seminars, exercises
Assessment of Work Load	Depending on the courses
Course Assessments and Examinations	Depending on the courses
Grading	Depending on the courses
Usability	MSc course *Advanced Materials*

MASTER THESIS

Module allocated to 4th semester

Module Code	
Credit Points	30
Weekly Classroom Hours per Semester	5 days with 8 hours work in laboratories, office and at home
Language of Instruction and Examinations	English
Duration of Module	1 semester
Cycle	Winter and summer semester
Responsible for Module	Prof. Dr. Paul Ziemann
Lecturers	Habilitated permanent members of Ulm University, in case of external master theses complemented by scientists qualified on a comparable level and individually assigned by the Examination Committee.
Allocation of Module to Study Programmes	Master degree in Advanced Materials
Prerequisites	At least 83 CPs
Learning Outcomes	*Thesis work:* After an introductory period of advice and guidance into the specific problems of a given master thesis, the students will be able to perform mostly independent the related scientific work. More specifically, they will be able to tackle the following tasks: – To survey the project related literature – To design or optimize an experimental set-up – To learn project specific preparational and analytical tools – To learn data acquisition & analysis including error considerations – To apply their acquired knowledge on writing scientific reports in order to deliver a scientifically consistent and formally complete thesis *Oral presentation of thesis results:* The student is able to prepare and deliver a scientific presentation based on the accomplishments gained during the thesis work.
Module Contents	– Preparation of an experimentally oriented master thesis – Oral presentation (45 min.) of the results of the master thesis
Literature	Supervisors will give hints how to search for project specific literature. General reading: *The Craft of Scientific Presentations,* by M. Alley, Springer Verlag, New York 2003.
Teaching Methods	Lab work, seminar
Assessment of Work Load	900 h
Module Assessments and Examinations	Students regularly report about progress of the thesis work to the supervisors, no additional examinations
Grading	Evaluation of the master thesis by two referees as described in the *General Examination Regulations for Bachelor and Master Studies, Ulm University (March 2010)*
Usability	MSc course *Advanced Materials*

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General Provisions for Study and Examination Regulations regarding Bachelor and Master Programmes at Ulm University (General Framework) of 3 March 2010

The Senate of Ulm University, in its meeting of 18 February 2010, adopted the following statutes pursuant to section 34(1) in connection with section 19(1) clause 2 no. 9 of the Law on Higher Education of the Land of Baden-Württemberg (LHG="Landeshochschulgesetz") in the version of 1 January 2005 (Law Gazette p. 1 ff), last amended by article 2 of the Second Law on the Implementation of the Federalism Reform in Higher Education of 3 December 2008 (Law Gazette p. 435 ff). The President of Ulm University approved these on 3 March 2010 pursuant to section 34(1) clause 3 LHG.

Preliminary remarks on language use

I. General provisions

II. Examinations in bachelor and master programmes

III. Final provisions

Preliminary remarks on language use

According to Article 3(2) Basic Law men and women have equal rights; all male designations of persons and positions used in this General Framework apply equally to men and women.

I. General provisions

Section 1 Scope of application

(1) These provisions are based on the legal requirements of the Framework Act for Higher Education ("Hochschulrahmengesetz") and the Law on Higher Education of the Land of Baden-Württemberg ("Landeshochschulgesetz") as well as the framework requirements of the Standing Conference of the Ministers of Education and Cultural Affairs of the Länder in the Federal Republic ("Kultusministerkonferenz") and the Accreditation Council. The framework requirements of the Standing Conference and the Accreditation Council are based on the communiqués of the European Ministers of Education and in particular on the regulations regarding the ECTS. They are applicable to all consecutive, non-consecutive and (post)graduate bachelor and master programmes offered at Ulm University.

(2) Objectives, subject-matter, organisation and performance requirements of the individual bachelor and master programmes are regulated in the respective Subject-Specific Study and Examination Regulations ("Fachspezifische Studien- und Prüfungsordnungen"). Based on these Subject-Specific Study and Examination Regulations the individual faculties shall prepare a module handbook for each degree programme comprising a curriculum.

(3) The Subject-Specific Study and Examination Regulations shall supplement these General Provisions regarding Bachelor and Master Programmes at Ulm University (General Framework). In cases of doubt, this General Framework shall have priority.

Section 2 Overall study objectives, academic degrees

(1) Bachelor programmes aim to establish a scientific and methodological basis in the respective sciences. The programme objective is to enable students to apply the acquired skills and knowledge in the context of their field of work and under guidance.

(2) Master programmes aim to deepen and broaden the scientific and methodological qualifications acquired during bachelor studies. (Post)graduate master programmes are designed to build on qualifications acquired during academic studies and on the job. Students should be capable of independently applying research findings and scientific methods and evaluating their significance and scope with a view to solving complex tasks in the scientific and social fields.

(3) Students who have successfully completed the bachelor examination shall be awarded the academic degree of “Bachelor of Science” (“B.Sc.”), or, in philosophy, the academic degree of “Bachelor of Arts” (“B.A”). In engineering, the academic degree of Bachelor of Engineering (“B.Eng.”) may be awarded.

(4) Students who have successfully completed the master examination shall be awarded the academic degree of “Master of Science” (“M.Sc.”). In engineering, the academic degree of Master of Engineering (“M.Eng.”) may be awarded. For (post)graduate and non-consecutive master programmes, other master’s degree titles diverging from these standard designations may be used.

Section 3 Beginning of programmes

The beginning of programmes is regulated in the Subject-Specific Study and Examination Regulations.

Section 4 Admission requirements of programmes

(1) To be admitted to a bachelor programme the candidates must fulfil the requirements stated in section 58(2) LHG or requirements recognized as equivalent. To be admitted to a master programme the candidate must fulfil the requirements stated in section 29(2) clauses 5 and 6 LHG.

(2) The faculties individually define further access and/or admission requirements for bachelor programmes in separate statutes specifying procedures for the determination of aptitude and selection and, for admission to master programmes, in separate admission statutes.

(3) The Subject-Specific Study and Examination Regulations may make special provisions for students wishing to change from the traditional Diplom, bachelor and master programmes and programmes requiring a state examination to the new bachelor and master programmes.

Section 5 Standard period of study, programme organisation, modules, credit points, supplementary modules

(1) Standard periods of study are a minimum of three academic years for bachelor programmes and a maximum of two academic years for master programmes, while non-consecutive or (post)graduate programmes comprise one or two academic years. As a rule, an academic year consists of two semesters.

(2) Module volumes are determined by students’ workload and quantified in credit points according to the European Credit Transfer and Accumulation System (ECTS). One credit

point (CP) corresponds to an average student workload of 30 hours. It is planned that students obtain 60 credit points per academic year and 30 CP per semester. As a rule, bachelor programmes require 180 CP while master programmes require 120 CP. Master programmes comprising bachelor programmes (consecutive master programmes) require 300 CP.

(3) Bachelor and master programmes require the performance of examinations and assignments. These may take various forms (e.g. written, oral, report of work placement, presentation). Moreover, students are required to write a bachelor's or master's thesis. Details are provided in the Subject-Specific Study and Examination Regulations. Students in bachelor programmes need to prove by way of an orientation examination that they have acquired the basic skills and knowledge required for their course of study and that they qualify in principle for the subjects chosen by them.

(4) Bachelor programmes with a standard period of study of more than three years comprise an intermediate examination requiring students to prove that they have acquired the basic technical and methodological skills necessary for successfully continuing their studies.

(5) Courses within the framework of bachelor's and master programmes are grouped into modules. Bachelor's and master's theses as well as external work placements form separate modules. Teaching and study contents of the individual modules are documented in a module form comprising standards according to Attachment 1 in the respective applicable version. All module forms of a degree programme together constitute the module handbook.

(6) The acquisition of credit points requires the successful completion of study requirements according to section 6(3) and is subject to passing the module examination according to section 6(2).

(7) Besides specialist modules, bachelor students are required to obtain a minimum of 6 CP from Additional Key Skills ("Additive Schlüsselqualifikationen") modules. Integrated key skills may form a separate module; they may, however, also be taught as part of other specialist modules.
The Subject-Specific Study and Examination Regulations may make recommendations on the choice of modules offered within the framework of Additional Key Skills.

(8) Besides compulsory modules, students may choose further modules (supplementary modules). Such supplementary modules may, at a student's request, be mentioned in their degree certificates.

Section 6 Module examinations, module responsibility, orientation examination, intermediate examination, deadlines

(1) Module examinations of bachelor and master programmes must be taken while enrolled in the programme during the examination periods specified in the Subject-Specific Study and Examination Regulations.

(2) Module examinations may consist of one or several examinations (partial module examinations). A module examination may also take the form of coursework. Details are

provided in the Subject-Specific Study and Examination Regulations. Unless otherwise provided for partial module examinations, the following regulations for module examinations shall equally apply to partial module examinations.

(3) The admission to module examinations according to paragraph 1 above may be tied to unmarked coursework. Details are provided in the Subject-Specific Study and Examination Regulations.

(4) As a rule, each module and how it is taught lies in the responsibility of one lecturer who reports on steps taken to ensure its performance to the dean of studies and the chairperson of the subject-specific board of examiners ("Fachprüfungsausschuss"). The respective dean of studies may entrust module responsibility to a member of the teaching staff. The module handbook of each degree programme lies in the responsibility of the dean of studies in charge.

(5) The Subject-Specific Study and Examination Regulations may make provisions for different forms of module examinations and retakes.

(6) By the end of the second semester bachelor students must have taken at least one partial module examination; this must be in one of the compulsory modules listed in the module handbook (orientation examination). The Subject-Specific Study and Examination Regulations define form, scope and volume of the partial module examination(s) that the candidate is expected to take. Should students exceed this deadline or fail the examination(s) they must be informed that they are in danger of losing their right to be examined unless they pass the required partial module examination(s) by the end of the third semester. Students who have not passed the required module examination(s) by the end of the third semester at the latest lose their right to be examined in this programme unless they are not responsible for exceeding the deadlines.

(7) Bachelor students enrolled in programmes whose standard period of study exceeds three years shall have taken module examinations in the compulsory modules listed in the module handbook (intermediate examination) by the end of the fourth semester. The Subject-Specific Study and Examination Regulations define form, scope and volume of the module examinations to be performed. Should students exceed this time limit or fail the examination(s) they must be informed that they are in danger of losing their right to be examined unless they pass the required partial module examinations by the end of the sixth semester. Students who have not passed the required module examinations by the end of the sixth semester at the latest shall lose their right to be examined in this programme unless they are not responsible for exceeding the time limits.

(8) Students enrolled in bachelor programmes should have the opportunity to take all module examinations in compulsory, core elective and elective modules listed in the module handbook by the end of the standard period of study. The Subject-Specific Study and Examination Regulations specify form, scope and volume and may specify the point of time when a specific module examination needs to be taken. Should students exceed deadlines or fail examinations they must be informed that they are in danger of losing their right to be examined unless they pass the required module examinations by the end of the deadlines. Students who have not passed the required module examinations one year at

the latest after the lapse of the deadlines shall lose their right to be examined in this programme unless they are not responsible for exceeding the deadlines.

(9) Paragraph 8 above shall apply analogously to master programmes.

(10) The respective subject-specific board of examiners shall decide, at the request of the student, whether a student is responsible for having exceeded the deadlines.

(11) In the events of paragraphs 8 or 9, section 22(5) above shall apply analogously.

Section 7 Lectures and examinations held in English

Lectures and examinations may be held wholly or partially in English or any other foreign language. Details are provided in the Subject-Specific Study and Examination Regulations.

Section 8 Work experience

The Subject-Specific Study and Examination Regulations may oblige students to do work experience and prescribe scope and content thereof.

Section 9 Student advisory services

The Subject-Specific Study and Examination Regulations may make student advisory services or a student mentoring system obligatory.

Section 10 Subject-specific board of examiners (“Fachprüfungsausschuss”)

(1) Boards of examiners responsible for the individual programmes shall be formed by resolution of the respective faculties (subject-specific boards of examiners). A board may be responsible for one or several degree programmes. Details are provided in the Subject-Specific Study and Examination Regulations.

(2) The subject-specific board of examiners shall be composed of full-time university lecturers, full-time professors of Ulm University, further scientific staff of the respective faculties and, in an advisory capacity, students. The number of board members and their term of office are specified in the Subject-Specific Study and Examination Regulations. It shall be possible to re-elect board members.

(3) The members of the subject-specific boards of examiners shall be appointed by the respective faculties. The subject-specific boards of examiners shall elect the chairperson and his or her deputies. Chairpersons and deputy chairpersons must be full-time university lecturers or full-time professors of Ulm University.

(4) To constitute a quorum either the chairperson of the subject-specific board of examiners or their deputy plus a total of at least half of the voting members must be present. Resolutions shall be adopted by a simple majority of votes; in the event of an equality of votes the chairperson shall have the casting vote.

(5) The subject-specific board of examiners may entrust the performance of all its ordinary tasks to the chairperson of the subject-specific board of examiners; this shall, however, not apply to decisions regarding objections.

(6) The members of the subject-specific board of examiners shall be bound by official secrecy. Should they not be civil servants, they shall be pledged to secrecy by the chairperson of the board.

(7) The members of the subject-specific board of examiners shall be entitled to attend examinations. This right shall not include the notification of examination results.

(8) The respective subject-specific board of examiners shall supervise the organisation of module examinations and is responsible for the performance of the tasks assigned to it within the scope of this General Framework and the Subject-Specific Study and Examination Regulations. It shall ensure compliance with this General Framework and the Subject-Specific Study and Examination Regulations and take decisions in examination-related matters. It shall decide on the accreditation of periods of study, programme achievements and module examinations and determine equivalence according to section 12. It shall periodically report to the respective faculties on the development of examination and periods of study, including time frames for bachelor's and master's theses and the distribution of subject and overall grades. It shall also make suggestions regarding the revision of the Subject-Specific Study and Examination Regulations and module descriptions.

(9) Where the subject-specific board of examiners takes incriminating decisions these shall be communicated to the student concerned in writing. They must be substantiated and accompanied by information about legal redress. Any appeals against decisions taken by the subject-specific board of examiners must be lodged with the Student Administration Office ("Studiensekretariat") either in writing or for the record within one months of receiving the decision. Where the subject-specific board of examiners does not allow the appeal, it must be submitted to the member of the "Präsidium" (executive committee) in charge of teaching for a decision.

(10) For the performance of its functions the subject-specific board of examiners shall utilize the administrative services of the Student Administration Office of Ulm University.

Section 11 Examiners and further board members

(1) The subject-specific board of examiners shall appoint the examiners and the further members of the board of examiners competent in the subject-matter of the examination. The subject-specific board of examiners may delegate the appointment of the further members of the board of examiners to the examiner in charge.

(2) Examiners shall be university lecturers and professors as well as members of the scientific staff of the respective faculties who have been conferred the right of examination. Only persons holding a degree which is equivalent to or higher than the candidate's prospective degree may be appointed as examiners or as further members of the board of examiners.

(3) Unless otherwise provided in the subject-specific study and examination regulations, as a rule, written module examinations shall be assessed by one examiner, and oral module examinations shall be assessed by one principal examiner in the presence of one or several further examiner(s). As a rule, the lecturers teaching the module shall also be the examiners. Paragraph 4 below shall remain unaffected.

(4) Unless otherwise provided in the applicable Subject-Specific Study and Examination Regulations, bachelor's theses shall be assessed by one examiner while master's theses shall be assessed by two examiners. Should a bachelor's thesis be marked "insufficient" (5.0) a second opinion regarding this bachelor's thesis must be obtained. In this event, section 17(5) shall apply analogously.

Section 12 Accreditation of periods of study, programme achievements and module examinations

(1) Any periods of study, equivalent programme achievements and module examinations performed in the same or any other programme at universities shall be recognised at the student's request. Equivalence exists where content, scope and requirements of the achievements essentially correspond to those of the programme concerned. This shall, however, not be based on a schematic comparison but on an overall view. Determination of the scope of a programme achievement or a module examination submitted for accreditation shall be based on the principles of ECTS; verification of equivalence regarding content and requirements shall be in line with learning targets and the skills to be acquired in the module.

(2) Where achievements are recognised, the marks shall be transferred –subject to the assessment systems being comparable- and count towards the module mark and the final mark. If there are no marks or the assessment systems are not comparable, the subject-specific board of examiners shall decide whether and, if so, which programme achievements or module examinations shall be recognised. The students must submit the documents required for accreditation.

(3) The accreditation of periods of study, programme achievements and module examinations performed outside the Federal Republic of Germany must comply with the agreements on equivalence ("Äquivalenzvereinbarungen") approved by the Standing Conference of the Ministers of Education and Cultural Affairs and the German Rectors Conference as well as agreements made as part of university partnerships.

(4) Paragraph 1 above shall also apply to periods of study, programme achievements and module examinations performed in state-certified distance programmes and other higher education institutions, in particular state or state-certified "Berufsakademien" (institutions offering three-year higher education courses combining academic training with in-company training).

(5) The accreditation of parts of the bachelor or master examination may be denied if more than half of the programme achievements and module examinations or more than half of the required credit points or the bachelor's or master's thesis are to be recognised for one programme. Sentence 1 shall not apply to programme achievements and module examinations performed in the teacher training for grammar schools programme ("Lehramt

für Gymnasien") and to the recognition of the thesis ("Wissenschaftliche Arbeit") completed within the teacher training for grammar schools programme as the bachelor's thesis; as a rule, such programme achievements and module examinations performed in the teacher training for grammar schools programme as well as the thesis ("Wissenschaftliche Arbeit") shall be recognised.

(6) Where foreign students as defined in section 60(1) sentence 2 LHG take and fail to pass examinations during a period of study completed in a degree programme at Ulm University, these failed examinations shall later, during a study course completed at Ulm University, count towards the number of failed attempts.

(7) Failed examinations in a bachelor or master programme at Ulm University shall, ex officio, count as failed attempts towards the permitted number of retakes. Sentence 1 shall also apply to any related study courses.

(8) The respective subject-specific board of examiners shall be responsible for accreditation issues. Before determining equivalence, the competent subject representatives ("Fachvertreter") must be consulted.

II. Examinations in bachelor and master programmes

Section 13
Organisation of module examinations

(1) The Subject-Specific Study and Examination Regulation(s) shall provide dates for written examinations and retakes of module examinations in compliance with the standard period of study and the examination periods in bachelor's and master programmes provided in section 6(6-9). Regarding examination periods, it is recommended that written module examinations in bachelor and master programmes are held in the last week of the semester and the following three weeks, while retakes are held in the three weeks before the following semester starts and in the first week thereof. As a rule, examinations at Ulm University are offered openly.

(2) Time and place of oral examinations shall be arranged by the examiners themselves.

(3) Regarding module examinations, the subject-specific board of examiners shall determine registration periods in line with examination periods according to paragraph 1 above within which registration must occur and which must be communicated to the students in a timely and adequate manner. Registration periods for module examinations shall end no later than three days before the examination date.

(4) To be admitted to module examinations, students must register in writing at the Student Administration Office. It is possible to register online for written and oral module examinations. Proof of the study achievements required for the respective module examination under the Subject-Specific Study and Examination Regulations must be presented in accordance with section 6(3). Registration according to paragraph 3 above shall be deemed to have occurred by the end of the registration period unless the student has revoked his or her registration at the Student Administration Office by this date. During the registration period, registration for examinations may be revoked without cause. If

registration for an examination is revoked, the examination shall be deemed not to be registered. On termination of the registration period, the examination date shall be binding, unless the student claims an important reason for late registration, withdrawal from the examination or failure to attend. An important reason for late registration may, in particular, be that participation in a module examination is subject to the prior submission of coursework which could only be completed after the registration deadline.

Section 14 Admission to module examinations

(1) Admission to module examinations shall be restricted to persons who

a) are enrolled in a bachelor of master programme at Ulm University,

b) submit proof of the study achievements or module examinations required for admission to the respective module examination under the Subject-Specific Study and Examination Regulations, and

c) have not lost their right to be examined or failed an examination at last attempt.

(2) Admission shall be denied if

a) the prerequisites stated in paragraph 1 above have not been fulfilled,

b) the documents are incomplete and have not been completed within the given time limits despite a request to do so,

c) students have failed an orientation, bachelor or master examination in their chosen programme or a related programme[1] at last attempt or have lost their right to be examined therein.

Admission shall be revoked if students are not enrolled in any bachelor or master programme at Ulm University or if they are on academic leave at the time of taking examinations.

(3) Students shall be informed of rejection of their application for admission by the Student Administration Office in writing. Rejections must be substantiated and accompanied by information about legal redress.

Section 15 Special regulations

Where students show credibly, e.g. by presenting a medical certificate, that they are fully or partially incapable of performing programme requirements and/or module examinations in the prescribed manner due to continuing or permanent physical impairment or disabilities, the subject-related board of examiners shall determine, in consultation with the student and the examiners, how equivalent programme achievements and module examinations may be performed either within a longer period of time or in a different manner.

Section 16 Module examinations

[1] Related programmes must be indicated in the subject-specific examination and study regulations; the curricula of bachelor and master programmes are essentially the same as those of Diplom programmes and therefore related.

(1) In module examinations students are expected to prove that they have attained the learning goals and acquired the corresponding skills described in the module handbook.

(2) Examiners shall inform candidates in good time about auxiliary means admitted for the module examination.

(3) The examiner shall communicate the examination result to the Student Administration Office directly after inspection according to section 25(2), and the examination documents (e.g. written test, record of the oral examination) shall be delivered to the Student Administration Office.

Section 16a Written module examinations

(1) Written module examinations shall be written examinations and other written work.

(2) Examinations may be set partially or completely as multiple choice tests. Further details are provided in the subject-specific study and examination regulations.

(3) As a rule, written examinations shall last between 60 and 180 minutes. Further details are provided in the subject-specific study and examination regulations.

(4) Assessment of written module examinations and bachelor's or master's theses shall not exceed 6 weeks from completion of the module.

Section 16b Oral module examinations

(1) Oral module examinations shall be e.g. oral examinations, reports and presentations.

(2) Oral module examinations shall take the form of individual or group examinations conducted, as a rule, by a principal examiner according to section 11(2) in the presence of a second examiner. The principal examiner shall consult the second examiner before determining the result. Examinations shall take between 10 and 50 minutes per student. Further details are provided in the subject-specific study and examination regulations.

(3) Key subject-matter and results of the examination must be recorded in a written report.

(4) Students wishing to take the same examination at a later date shall be permitted to attend as far as the available space allows this unless the examination candidate objects to their presence. This permission shall, however, not include the consultation and the notification of examination results. The public shall be excluded for important reasons or at the request of the examination candidate.

Section 16c Admission to the modules bachelor's and master's theses and requirements

(1) The requirements for admission to the modules bachelor's and master's theses are specified in the respective subject-specific study and examination regulations. The application for admission to the bachelor's and master's theses must be filed no later than 3 months after taking the last module examination, unless the respective subject-specific study and examination regulations provide otherwise. If students fail to meet this deadline

without good cause, the bachelor's or master's thesis shall be marked "insufficient" (5.0) in the first attempt. In all other respects, section 14 shall apply analogously.

(2) When students comply with the requirements under paragraph 1, they shall contact a university lecturer to request a topic. Students shall be given the opportunity to make their own suggestions for a topic. The chairperson of the subject-specific board of examiners shall ensure that students receive topics for their bachelor's or master's thesis no later than 6 weeks after filing the application.

(3) The bachelor's thesis shall be equivalent to 6 to 12 credit points; the master's thesis shall be equivalent to 15 to 30 credit points with the exception of master's theses prepared under special agreements with partner universities outside the scope of application defined in section 1. Producing such papers shall give students the opportunity to show that they are capable of elaborating a topic taken from their major subject using scientific methods within a fixed period. The respective subject-specific study and examination regulations may require the presentation of the bachelor's or master's thesis or a defence of the thesis to be part of the examination. Extra credit points, which may be recognised as integrated key skills, shall be awarded for the presentation or the defence.

(4) The subject-specific study and examination regulations may allow group work. Group work is admissible as long as individual contributions are clearly definable and assessable.

(5) The topic of the bachelor's or master's thesis is issued by an examiner according to section 11(2) sentence 1. Subject to previous approval by the subject-specific board of examiners, the issue of the topic and supervision of the thesis may be performed by an examiner who is not a member of the faculty, as long as the choice of the topic is approved by a lecturer performing research and teaching in the programme, who is a member of the faculty's group of examiners. Sentence 2 shall apply analogously to any institution recognised as equivalent to the university. The examiner issuing the topic of the bachelor's or master's thesis shall also act as the thesis advisor.

(6) The topic of the bachelor's or master's thesis shall be issued via the subject-specific board of examiners together with the admission to the bachelor's or master's thesis. The time of issue and the topic of the thesis must be made known to the Student Administration Office. The time allowed for the completion of the thesis shall begin when the topic is issued.

(7) The respective subject-specific study and examination regulations shall provide the time frame allowed for the completion of the bachelor's and master's thesis and the number of corresponding credit points. The choice of the topic and supervision must be in line with the time allowed for its completion. Unless the subject-specific study and examination regulations provide otherwise, the subject-specific board of examiners may extend the time allowed for the completion of the bachelor's thesis by up to 2 weeks and the time allowed for the completion of the master's thesis by up to 4 weeks if the student requests this with good cause. The request must be submitted to the subject-specific board of examiners at least two weeks before the end of the time allowed for the completion of the thesis and requires the advisor's approval.

(8) The topic of the thesis may be returned only once and only during the first month of the time allowed for its completion. A new topic must be set and issued within four weeks in accordance with paragraph 2 above. In this context, also see section 20(6) sentence 3.

(9) Bachelor's and master's theses must be submitted to the Student Administration Office within the specified time limits. The Student Administration Office must receive a copy for examination purposes on an electronic data medium. The subject-specific study and examination regulations also indicate how many copies must be submitted for the examiners and in what form (e.g. electronic). This shall not affect regulations between students and the library (KIZ) regarding rights of use and exploitation of such theses. The deadline for submission must be put on file. If the bachelor's or master's thesis is not submitted within the fixed time limits it shall be deemed to have been marked "insufficient" (5.0) unless the student is not responsible for exceeding the time limit.

(10) On submitting their bachelor's or master's thesis students must affirm in writing that they wrote the thesis independently and did not use any other sources and means than those indicated by them; furthermore, that they cited all passages where they quoted or referred to others' works and their contents and that they complied with the Statutes of Ulm University on Safeguarding Good Scientific Practice in the applicable version. Should this affirmation not be true, the bachelor's or master's thesis shall be marked "insufficient" (5.0). Where scientific misconduct according to sentence 1 is established, the necessity of taking further action under the Statutes of Ulm University on Safeguarding Good Scientific Practice shall be considered.

(11) The bachelor's or master's thesis must be written in German unless the subject-specific study and examination regulations provide otherwise.

Section 17 Assessment of module examinations (including bachelor's and master's theses), calculation of final result

(1) Assessment of module examinations is only obligatory where these count towards the final result of the degree programme. The subject-specific study and examination regulations determine which modules shall be considered (modules counting towards final result).

(2) All examinations requiring marks shall be awarded one of the following marks:

1	=	very good	=	an outstanding achievement
2	=	good	=	an achievement far above average requirements
3	=	satisfactory	=	an achievements fulfilling average requirements
4	=	sufficient	=	an achievement fulfilling minimum requirements despite some deficiencies
5	=	insufficient	=	an achievement not fulfilling minimum requirements due to considerable deficiencies

For a more differentiated assessment it is possible to form intermediate marks by increasing or decreasing a mark by 0.3. However, the following marks are excluded: 0.7; 4.3; 4.7 and 5.3.

(3) If a module requires a module examination, the mark given for this examination shall be the mark awarded for this module. If a module requires partial module examinations, the mark awarded for the module shall be calculated as the arithmetic mean of the marks (in digits) of the individual achievements appertaining to the respective module weighted according to their allocated credit points. Module examinations shall be weighted according to their allocated credit points unless the subject-specific study and examination regulations provide otherwise. For the calculation of the module mark, the mark shall be rounded to one decimal place (commercial rounding). Where the second decimal place is five and all other decimal places are zero, however, the mark is rounded down.

(4) Marks shall be awarded according to the table below:

Individual mark	Final mark	In words German	English
1.0 1.3	1.0 – 1.5	sehr gut	very good
1.7 2.0 2.3	1.6 – 2.5	gut	good
2.7 3.0 3.3	2.6 – 3.5	befriedigend	satisfactory
3.7 4.0	3.6 – 4.0	ausreichend	sufficient
Higher than 4.0		nicht ausreichend	insufficient

(5) As a rule, the bachelor's and master's thesis shall be assessed by the examiner who set the topic. If the thesis must be assessed by a second examiner, he or she shall be appointed by the subject-specific board of examiners. Paragraph 2 above shall apply analogously to the assessment of bachelor's and master's theses. The mark awarded for the bachelor's or the master's thesis must count towards the final result. In the event of section 11(4) sentence 2 and regarding the master's thesis, the result shall be calculated as the arithmetic mean of the individual marks. Paragraph 2 sentences 2 and 3 shall apply analogously. Where there is a divergence of more than two marks between the two examiners, the subject-specific board of examiners shall consult a third expert. The subject-specific board of examiners shall then determine the result within the scope of previous assessments.

(6) The final result of the bachelor's and master's examinations shall be calculated as the weighted mean of all module marks counting towards the final result including the marks of the bachelor's and master's thesis. For this calculation, the module marks and the marks of the bachelor's and master's theses shall be weighted according to their allocated credit points unless the subject-specific study and examination regulations provide otherwise. Where students completed modules in addition to the prescribed modules within the examination periods defined in section 6(6-9) (supplementary modules), only the modules required for passing the bachelor's and master's examination shall count towards the final

result. Supplementary modules shall not be taken into consideration. Paragraphs 3 and 4 above shall apply analogously to the calculation of the final result.

(7) Module examinations in the field of additional key skills shall be count towards the final result unless the respective subject-specific study and examination regulations provide otherwise; however, this shall not apply to external work experience.

(8) Where the final result is better than or equals 1.1, the grade “mit Auszeichnung” (“with distinction”) shall be awarded.

Section 18 Passing and failing of module examinations

(1) A module examination shall be deemed to be passed if the module mark is “sufficient” (4.0) or better. Where a module examination consists of more than one examination, all appertaining examinations (partial module examinations) must be marked “sufficient” (4.0) or better.

(2) The bachelor’s and the master’s thesis as well as the presentation, if required, shall be deemed to have been passed according to the subject-specific study and examination regulations if all of them were marked “sufficient” (4.0) or better.

(3) If a bachelor’s and master’s thesis was failed or is deemed to have been failed, the Student Administration Office shall notify the student thereof in writing providing the information specified in section 20(6). The notification shall be accompanied by information about legal redress.

Section 19 Examinations failed at last attempt

(1) The bachelor’s or master’s thesis shall be failed if

a) the bachelor’s or master’s thesis was failed or was deemed to have been failed at the second attempt,

b) students failed a retake of an exam at last attempt according to the subject-specific study and examination regulations or this retake is deemed to have been failed,

c) students’ rights to be examined was forfeited due to their exceeding the time limits.

(2) Section 22(5) shall apply analogously.

Section 20 Retake of module examinations

(1) Module examinations in compulsory modules that were marked “fail” (5.0) or that are deemed to be failed may be retaken once unless the respective subject-specific study and examination regulations provide otherwise. Where a module examination is composed of more than one examination, only the examinations must be retaken that were not marked “sufficient” (4.0) or better. It is not permitted to retake a module examination that was passed unless the respective subject-specific study and examination regulations provide otherwise.

(2) The subject-specific study and examination regulations may provide that module examinations in compulsory elective or elective modules may be retaken more than once.

(3) Retakes of module examinations must be taken within the examination periods specified in the subject-specific study and examination regulations. A student's right to be examined shall terminate if they fail to meet the deadlines provided for the last retake unless the student is not responsible for the default.

(4) Retakes of module examinations not taken within the examination periods of the semester following the semester in which the examination was failed may be conducted in another form than prescribed in the subject-specific study and examination regulations if subject-specific circumstances require this. In such event, the form of the examination to be taken by the student in the retake of the module examination must be communicated to the student at the time of arranging the date of the retake at the latest.

(5) Bachelor's or master's theses that were marked "insufficient" (5.0) or are deemed not to have been passed may be retaken once. The application for a retake of the examination must be filed no later than two months after enforceability of the examination notification. Where this deadline is not met, students shall lose their right to be examined unless they are not responsible for the default. Students may only return topics if they did not make use of this option at first attempt.

(6) Oral presentations that were marked "insufficient" may be repeated once.

Section 21 Termination of the degree programme

(1) Students shall be deemed to have successfully completed their bachelor or master programme when they have successfully performed all achievements and modules required for the respective programme by the subject-specific study and examination regulations and obtained the number of credit points necessary for passing a bachelor or master programme.

(2) Where students did not successfully complete their degree programme, they shall receive, together with their proof of exmatriculation, a certificate documenting all examinations they completed successfully and, where applicable, further programme achievements as well as marks in accordance with Attachment 2 in the applicable version.

Section 22 Examination certificate, transcript of records, diploma supplement, degree certificate

(1) Students shall be awarded examination certificates of successfully completed bachelor and master programmes within four weeks of passing the last module examination. These certificates shall show the final result of the bachelor or master examination (up to one decimal place), the ECTS degree according to paragraph 2 below, the modules completed in the course of the bachelor or master programme, the module marks counting towards the final result according to section 17(4), the topic and the mark of the bachelor's or master's thesis as well as the oral presentation on the topic of the thesis, if any, and supplementary modules, if any. The certificate shall bear the date of the last module examination and must be signed by the chairperson of the subject-specific board of

examiners. The examination certificate shall be made out according to Attachment 3 in the applicable version. In degree programmes taught in English the certificate shall be made out in English.

(2) Final results of bachelor and master examinations shall be ranked. Students shall be placed in the cohort of students that have passed the bachelor or master examination in the 12 months preceding the ranked student's final successful module examination. The certificate shall indicate the student's position in the ranking, the size of the cohort and the number of students occupying the same rank.

(3) The bachelor's and master's certificate shall be accompanied by a transcript of records according to Attachment 4 in the applicable version and a diploma supplement according to Attachment 5 in the applicable version. In addition to the student's personal data, the diploma supplement shall give information on the type and "level" of the degree, the status of Ulm University and a detailed description of the degree programme in which the degree was obtained. The transcript of records and the diploma supplement shall be made out in English and in German.

(4) Together with the examination certificate the student shall be awarded the bachelor's or master's degree certificate bearing the same date as the examination certificate, testifying the award of the bachelor's or master's degree according to section 2. The degree certificate shall be signed by both the dean and the chairperson of the subject-specific board of examiners and sealed with the seal of the University.

(5) Students who did not pass their bachelor or master examination at last attempt shall receive a written notification thereof accompanied by information about legal redress. Section 21(2) shall apply accordingly.

(6) On request, examination and degree certificates of programmes taught in German shall also be made out in English; the same shall apply to English language programmes. The request must be made within five years of the date of exmatriculation.

III. Final provisions

Section 23 Default, withdrawal, deception, administrative offence

(1) Module examinations shall be deemed to have been failed if students fail to appear on examination dates without good cause or if they withdraw from an examination between registration and the end of the examination without good cause. The same shall apply if a bachelor's or master's thesis is not submitted within the allowed time period unless the student is not responsible for the default.

(2) The reason claimed in justification of the withdrawal or the default must immediately be indicated to the subject-specific board of examiners in writing and proved to be credible. Where students claim illness or the illness of their child or a dependent in their exclusive care, they may be asked to present a medical attest or, in case of doubt, a medical attest made out by a physician to be named by the subject-specific board of examiners. A withdrawal may not be accepted if students have, at the time of the occurrence of the obstacle, already taken parts of the examination whose result is such that the examination

cannot be successfully completed. If the reason is accepted, a new date shall be scheduled. In such case, the previously obtained examination results shall be recognised.

(3) Where students attempt to manipulate results of module examinations by deceiving or using inadmissible resources, the respective module examination shall be marked “insufficient” (5.0). In aggravated cases or in cases of repeated attempts at manipulation, the board of examiners may exclude the student from further retakes leading to their irreversible loss of the right to be examined in this programme. Where module examinations consist of more than one examination, the examination achievements attained in this module up to the time of an accepted withdrawal or an accepted default regarding an examination achievement within this module shall be recognised.

(4) Bachelor’s and master’s theses whose wording coincides wholly or in essential parts with that of other works and publications without identifying such passages as direct quotations and referencing the sources shall be marked as failed.

(5) In aggravated or repeated cases of paragraph 4 above, students may be excluded from all further studies and examinations in this programme at Ulm University. This shall comprise retakes of examinations. In such case, exmatriculation shall be considered in consultation with the responsible faculty council and the presidential board.

(6) Students disrupting the orderly conduct of an examination may be excluded from continuing the module examination by the responsible examiner or supervisor. In such cases, the respective examination shall be deemed to be “insufficient” (5.0). In particularly serious cases, the subject-specific board of examiners may exclude the students from taking further examinations.

(7) Students may demand within a four-week period that decisions taken under paragraph 3 and 4 be reviewed by the subject-specific board of examiners. Decisions by the subject-specific board of examiners incriminating a student shall be communicated to the student in writing without delay. They must be substantiated and accompanied by information about legal redress. The student must be given the opportunity to comment before a decision is taken.

Section 24 Terms of protection

(1) At a student’s request maternity protection periods as defined in sections 3(1) and 6(1) of the Federal Maternity Protection Act (MuSchG) in the version of its publication of 20 June 2002 (Federal Law Gazette I 2318) in the applicable version must be considered. The request must be accompanied by proof as required. Maternity protection periods shall interrupt any periods provided by these study and examination regulations. The maternity protection periods shall not be considered as part of these periods.

(2) At a student’s request, parental leave periods must likewise be considered under the Federal Parental Allowance and Parental Leave Act (BEEG) of 5 December 2006 (Federal Law Gazette I 2748) in the applicable version. Students must inform the Student Administration Office in writing of the period(s) of time during which they intend to take their parental leave no later than four weeks before doing so and submit all required proof. The Student Administration Office must verify whether the legal requirements that would

trigger an employee's claim to parental leave are fulfilled and shall communicate the outcome to the student, and, if applicable, inform him or her of the newly scheduled examination dates. Paragraph 1 sentences 2 and 4 above shall apply accordingly.

(3) Students on leave for one of the reasons mentioned in paragraphs 1-3 may do coursework and take module examinations as defined in section 61(3) clause 2 LHG.

(4) Family commitments are social commitments met by a student within the concept of "family" as defined by Ulm University in its auditing as a "family-friendly university" [2]. These are, in particular, the care of children under 14 and of dependents in need of care. Where students meet family commitments, paragraph 2 (2-4) shall apply accordingly. Extension periods because of family commitments shall, as a rule, be limited to two semesters.

Section 25 Revocation of an academic degree

(1) If a student committed deception during an examination and this becomes known after the award of the examination certificate, the results of the module examinations in which the student committed deception may be corrected. If applicable, the module examination may be declared to be "insufficient" (5.0) and the bachelor or master examination to be failed.

(2) Where requirements for admission to an examination were not fulfilled without the student attempting to deceive anybody and where this fact becomes known only after the award of the examination certificate, this defect shall be remedied by the fact that the student passed the examination. Where a student intentionally obtained admission wrongfully, the module examination may be declared to be "insufficient" (5.0) and the bachelor or master examination to be failed.

(3) The student must be given the opportunity to comment before a decision is taken.

(4) The incorrect examination certificate must be withdrawn and, if applicable, a new one must be issued. If the bachelor or the master examinations are declared to be failed on the grounds of deception, the bachelor's or master's degree certificate must be withdrawn together with the incorrect examination certificate.

(5) Decisions based on paragraph 1 or paragraph 2 sentence 2 above shall be excluded after expiration of a five-year period from the date of the examination certificate.

(6) Revocation of the academic degree shall comply with legal provisions.

Section 26 Right to inspection

[2] According to this definition, "family" is a social network. "Family" is the union of a couple with or without children intended to be durable and characterised by mutual responsibility. Besides the two-generation nuclear family (father, mother, children, siblings and their relationships), the concept of family also comprises non-marital relationships, homosexual relationships, blended families and foster families. Where direct social responsibility cannot be met in the two-generation model, family can also mean a three-generation model (grandchildren and grandparents).

(1) On application, students shall have the right to inspect their bachelor's or master's thesis, the appertaining opinions and the examination records within one year of completion of their bachelor's or master's examination.

(2) Regarding the inspection of written module examinations or examination records, a period of four weeks starting on the date of notification of the examination result shall apply.

(3) The examiner shall determine place and time of the inspection.

Section 27 Effective date and transitional provisions

(1) The General Provisions for Study and Examination Regulations regarding Bachelor and Master Programmes at Ulm University shall take effect on the day after their publication in the Official Bulletin ("Amtlichen Bekanntmachungen") of Ulm University. They shall be published in the Official Bulletin of Ulm University in their respective applicable version.

(2) At the same time, the General Provisions for Study and Examination Regulations regarding Bachelor's and Master Programmes at Ulm University (General Framework) ("Allgemeinen Bestimmungen zu Studien- und Prüfungsordnungen für das Bachelor- und Masterstudium an der Universität Ulm (Rahmenordnung)") of 18 March 2009 (Official Bulletin of Ulm University, 23 March 2009, no. 3, pp 49-79), and the following study and examination regulations of Diplom study courses

Biology, of 12 December 2001 (Bulletin of Ulm University, 21 December 2001, no. 13, pp 293-316), first amendment statutes of 23 February 2004 (Bulletin of Ulm, 08 March 2004, no. 2, pp 11-22), second amendment statutes of 13 December 2004 (Official Bulletin of Ulm University, 22 December 2004, no. 18, p 135),

Chemistry, of 20 July 2000 ("Amtsblatt Wissenschaft, Forschung und Kunst", no. 9, p 713 of 15 September 2000),

Electrical engineering and information technology, of 03 September 2001 (Official Bulletin of Ulm University, 03 September 2001, no. 9, pp 129-214), first amendment statutes of 21 May 2002 (Official Bulletin of Ulm University, 10 June 2002, no. 9, pp 122-125),

Computer sciences (computer science, computer science intensive course, media informatics), of 04 September 2001 (Official Bulletin of Ulm University, 19 September 2001, no. 11; pp 218-281),

Mathematics, of 20 July 2000 ("Amtsblatt Wissenschaft, Forschung und Kunst", no. 9, p 739 of 15 September 2000), first amendment statutes of 18 January 2002 (Bulletin of Ulm University, 13 February 2002, no. 1, pp 1-17), second amendment statutes (Official Bulletin of Ulm University, 16 November 2004, no. 17, pp 127-129),

Physics, of 20 July 2000 ("Amtsblatt Wissenschaft, Forschung und Kunst", no. 9, p 719 of 15 September 2000),

Chemistry and Business, of 23 January 2001 (Bulletin of Ulm University, 31 January 2001, no. 2, pp 7-33), first amendment statutes of 23 February 2004 (Bulletin of Ulm University, 08 March 2004, no. 2, pp 11-22),

Mathematics and Business, of 20 July 2000 ("Amtsblatt Wissenschaft, Forschung und Kunst", no. 9, p 693 of 15 September 2000), first amendment statutes of 18 January 2002

(Official Bulletin of Ulm University, 13 February 2002, no. 1, pp 1-17), second amendment statutes of 02 November 2004 (Official Bulletin of Ulm University, 16 November 2004, no. 17, p 128), third amendment statutes of 27 June 2005 (Official Bulletin of Ulm University, 11 July 2005, no. 13, pp 113-115),

Physics and Business, of 20 July 2000 ("Amtsblatt Wissenschaft, Forschung und Kunst", no. 9, p 725 of 15 September 2000),

Economics, of 17 December 2003 (Official Bulletin of Ulm University, 17 December 2003, no. 22, pp 186-208),

as well as the study and examination regulations of the following bachelor and master programmes

Biochemistry, of 05 Mai 2003 (Official Bulletin of Ulm University, 12 May 2003, no. 6, pp 39-59),

Molecular Medicine, of 20 May 2003 (Official Bulletin of Ulm University, 30 May 2003, no. 8, pp 67-82), first amendment statutes of 13 December 2004 (Bulletin of Ulm University, 22 December 2004, no. 18, pp 130-139),

Computer science, of 05 May 1999 ("Amtsblatt Wissenschaft, Forschung und Kunst", no. 6, p 217 of 22 June 99), first amendment statutes of 25 July 2000 („Amtsblatt Wissenschaft, Forschung und Kunst, no. 10, p 764 of 29 September 2000), second amendment statutes of 23 February 2004 (Official Bulletin of Ulm University of 08 March 2004, no. 2, pp 11-22),

Telecommunications and media technology, of 16 August 2001 (Official Bulletin of Ulm University, 03 September 2001, no. 9, pp 129-214), first amendment statutes of 24 April 2002 (Official Bulletin of Ulm University, 03 May 2002, no. 5, pp 89-90),

Mathematics, of 20 June 2001 (Bulletin of Ulm University, 20 June 2001, no. 5, pp 54-79), first amendment statutes of 18 January 2002 (Official Bulletin of Ulm University, 13 February 2002, no. 1, pp 6-7), second amendment statutes of 2 November 2004 (Bulletin of Ulm University, 16 November 2004, no. 17, p 129),

Philosophy, of 28 July 2003 (Official Bulletin of Ulm University, 18 August 2003, no. 14, pp 136-154),

Master of Finance, of 12 May 2003 (Official Bulletin of Ulm University, 16 June 2003, no. 10, pp 93-110),

Master of Communications Technology, of 23 July 2004 (Official Bulletin of Ulm University, 04 August 2004, no. 12, pp 82-96),

Master of Advanced Materials, of 15 November 2002 (Official Bulletin of Ulm University, 04 December 2002, no. 19, pp 168-203),

shall cease to have effect subject to paragraphs 3 and 4 below.

(3) The study and examination regulations of Diplom study courses shall remain effective until the respective subject-specific study and examination regulations for bachelor and master programmes take effect. Students enrolled in Diplom study courses at the time when these study and examination regulations take effect shall continue their studies under the study and examination regulations of such Diplom study courses; however, they may on application change to one of the bachelor or master programmes. The right to be

examined and to be awarded a Diplom examination certificate under the study and examination regulations of Diplom study courses shall terminate on 30 September 2016.

(4) Students enrolled in a bachelor or master programme at the time when these study and examination regulations take effect may, on irrevocable written application to the Student Administration Office, be examined under these General Provisions for these Study and Examination Regulations. Students not filing such an application shall take the bachelor or master examination under the study and examination regulations indicated in paragraph 2 above. Bachelor and master examinations under the study and examination regulations named in paragraph 2 above may be taken no later than the end of the 2010/2011 winter semester (in the case of bachelor students) or the end of the 2009/2010 winter semester (in the case of master students).

Attachments:
Attachment 1: Module form
Attachment 2: Certificate
Attachment 3: Examination certificate
Attachment 4: Transcript of Records
Attachment 5: Diploma Supplement

Ulm, 3 March 2010

Professor Dr. Karl-Joachim Ebeling
- President -

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Subject-Specific Study and Examination Regulations for the English Language Master Programme "Advanced Materials" offered by the Faculties of Natural Sciences, Engineering and Computer Science as well as Medicine of Ulm University of 8 July 2010

At the proposal of the Faculties of Natural Sciences, Engineering and Computer Science as well as Medicine, the Senate of Ulm University, in its meeting of 16 June 2010, adopted the following regulations pursuant to section 19 (1) clause 2 no. 9 in conjunction with section 34 of the Law on Higher Education of the Land of Baden-Württemberg (LHG="Landeshochschulgesetz") (Law Gazette of 27 December 2005 p. 794ff), last amended by article 2 of the Second Law on the Implementation of the Reform of Federalism in Higher Education ("Zweites Gesetz zur Umsetzung der Föderalismusreform im Hochschulbereich") of 3 December 2008 (Law Gazette p. 435ff).. The President of Ulm University approved these on 8 July 2010 pursuant to section 34 (1) clause 3 LHG.

Table of contents

Preliminary remarks on language use

According to Article 3 (2) Basic Law men and women have equal rights; all male designations of persons and positions used in this General Framework apply equally to men and women.

I. General provisions

Section 1 Scope of application

(1) These Subject-Specific Study and Examination Regulations contain specific regulations for the master programme “Advanced Materials”.

(2) The Subject-Specific Study and Examination Regulations supplement the General Provisions for Study and Examination Regulations regarding Bachelor and Master Programmes at Ulm University (General Framework). In case of doubt, the General Framework shall have priority.

Section 2 Study objectives, academic degree (General Framework, section 2)

(1) The master programme “Advanced Materials” is a research-oriented study course. It aims to enable graduates to independently work on problems in the field of materials science related to the fact that properties of materials can significantly be influenced by altering their structure on a nanometric scale. To do so, students are trained to apply methods from natural and engineering sciences; if they select the specialty area “Biomaterials” these are supplemented by approaches and techniques from medicine and biology. In both specialty areas, i.e. “Nanomaterials” and “Biomaterials”, the study objective is to acquire knowledge and skills qualifying graduates to work in research and development in the areas of natural and engineering sciences as well as in materials science of biocompatible materials, especially at universities, research institutes and those sectors of the industry that engage in research and development. Students indicate their selection of specialty area, i.e. “Nanomaterials” or “Biomaterials”, when registering for their first examination in the master programme.

(2) Ulm University offers the non-consecutive master programme “Advances Materials” leading to the academic degree of “Master of Science” (“M.Sc.”).

Section 3 Beginning of the programme (General Framework, section 3)

The master programme “Advanced Materials” begins in the winter semester.

Section 4 Standard period of study (General Framework, section 5)

The standard period of study of the master programme is four semesters.

Section 5 Deadlines (General Framework, section 6(9))

(1) By the end of the examination period of the fourth subject-specific semester in the master programme “Advanced Materials”, students must have completed (partial) module examinations pursuant to section 13 in compulsory and compulsory elective modules corresponding to a minimum of 83 credit points (CP). By the end of the examination

period of the sixth subject-specific semester, students must have completed (partial) module examinations pursuant to section 13 in compulsory and compulsory elective modules corresponding to a minimum of 120 CP and completed their master's thesis.

(2) The right to be examined expires if the student does not obtain the number of CP specified in paragraph 1 above during the period specified in paragraph 1 above unless he or she is not responsible for their failure to obtain the required number of credit points within the specified deadlines.

Section 6 Types of courses and examinations

Objectives and contents of the programme shall be conveyed in the following types of courses:

- lectures
- exercises
- tutorials
- laboratory courses
- project work
- seminars
- field trips

Examinations may be written or oral.

Section 7 Courses and examinations in English (General Framework, section 7)

The language of courses and examinations is English.

Section 8 Subject-specific board of examiners (General Framework, section 10)

(1) A subject-specific board of examiners shall be formed for the master programme "Advanced Materials".

(2) The subject-specific board of examiners shall consist of 7 members. It shall be composed of four full-time lecturers and full-time professors of Ulm University, one from the Faculty of Engineering and Computer Science, one from the Faculty of Medicine and two from the Faculty of Natural Sciences; one scientific staff member from any of the faculties involved in the programme; and two students in an advisory capacity. The students shall be from different semesters in the master programme "Advanced Materials". The term of office of the university lecturers, the full-time professors of Ulm University and the member of the scientific staff shall be three years; the term of office of the student members shall be one year. Reappointment is possible.

(3) The subject-specific board of examiners shall decide in cases of doubt covered by neither these examination regulations nor the General Framework.

Section 9 Organisation of module examinations (General Framework, section 13)

Deviating from the recommendations made in section 13(1) of the General Framework, written module examinations in the master programmes shall be held, as a rule, in the three weeks

following the end of the lecture period of each semester; examination retakes shall be held in the two weeks after the beginning of the following lecture period.

Section 10 Related study courses (General Framework, section 14)

Related study courses as defined in section 14 of the General Framework shall be, in particular, physics and chemistry. The subject-specific board of examiners shall decide on the eligibility of study courses not mentioned in sentence 1.

Section 11 Provisions regarding the module master's thesis (General Framework, section 16c)

(1) The master's thesis shall correspond to 30 CP. Students shall have six months to complete the master's thesis. This period may be extended by up to three months after approval by the board of examiners.

(2) The master's thesis shall comprise a presentation of approx. 45 minutes including a discussion of the contents and the obtained research results presented in the master's thesis.

(3) If the master's thesis is done outside Ulm University in accordance with section 16c(5) of the General Framework, a supervision plan must be submitted summarising the planned work and showing the approval by the external advisor.

(4) The master's thesis must be submitted to the Student Administration Office ("Studiensekretariat") in three bound copies and as one electronic copy (pdf) in accordance with section 16c(9) sentence 2 of the General Framework .

(5) The master's thesis must be written in English.

Section 12 Assessment of module examinations (General Framework, section 17)

(1) The modules counting towards the aggregate mark of the master examination shall be the modules marked as such in section 14 and the "Master's thesis".

(2) The calculation of the aggregate mark of the master examination is based on the module results in accordance with section 17(3) of the General Framework. The mark of the master's thesis is considered in double weighting.

Section 13 Retake of module examinations (General Framework, section 20)

(1) Up to 4 failed (partial) module examinations may be retaken twice after a failed attempt but only in the study year following the failed attempt. Where a student fails to take a (partial) module examination in the period specified in sentence 1, they shall lose the right to be examined unless they are not responsible for exceeding the deadline.

(2) If a student fails to pass a retake in a compulsory elective module, he or she may, after undergoing course guidance, change to another compulsory elective module. Such a change is possible only once.

Section 14 Study contents, admission to (partial) module examinations

(1) All modules end with a module examination or several partial module examinations.

(2) The following modules must be completed:

a) Specialty area Nanomaterials:

No.	Module	C/CE	CP	Course type*	Type of exam*[1]	Semester	Counts towards final mark
1	Materials Science I	C	10	L, S, LC	wr or o	1	yes
2	Materials Science II	C	10	L, S, LC	wr or o	2	yes
3	Chemistry	C	11	L, S	wr or o	1,2	yes
4	Physics	C	9	L, S, LC	wr or o	1,2	yes
5	Engineering	C	5	L, S	wr or o	1	yes
6	Nanomaterials I	C	8	L, S, LC	wr or o	2,3	yes
7	Nanomaterials II	C	13	L, S	wr or o	3	yes
8	Additional Key Skills	CE	8	L, S	wr or o	1,2,3	no
9	Master's Thesis	C	30	M	wr	4	yes (x2)
10	Electives	CE	16	L, S, LC	wr or o	1,2,3	yes

C = compulsory, CE = compulsory elective, V = lecture, S = seminar, LC = laboratory course, M = master's thesis
wr = written, o = oral

b) Specialty area Biomaterials:

No.	Module	C/CE	CP	Course type*	Type of exam*[1]	Semester	Counts towards final mark
1	Materials Science I	C	10	L, S, LC	wr or o	1	yes
2	Materials Science II	C	10	L, S, LC	wr or o	2	yes
3	Chemistry	C	11	L, S	wr or o	1,2	yes
4	Physics	C	9	L, S, LC	wr or o	1,2	yes
5	Biology and Cell Biology	C	5	L, S	wr or o	1	yes
6	Biomaterials I	C	5	L, S, LC	wr or o	2	yes
7	Biomaterials II	C	8	L, S	wr or o	2,3	yes
8	Additional Key Skills	CE	8	L, S	wr or o	1,2,3	no
9	Master's Thesis	C	30	M	wr	4	yes (x2)
10	Electives	CE	24	L, S, LC	wr or o	1,2,3	yes

C = compulsory, CE = compulsory elective, V = lecture, S = seminar, LC = laboratory course, M = master's thesis
wr = written, o = oral

(3) The module handbook specifies which examinations and courses may be selected for the compulsory elective modules.

(4) Within the module “Additional Key Skills”, students who are native speakers of German as well as foreign nationals with a German university entrance qualification (“Bildungsinländer”) and students with an excellent knowledge of German (corresponding to DSH-1) must complete courses offered by the “Sprachenzentrum” (language centre) or by the “Humboldt-Studienzentrum” (Humboldt study centre). These courses must be approved by the board of examiners and must be notified to the Student Administration Office (“Studiensekretariat“). Students not covered by sentence 1 must obtain a total of 8 CP from the courses “German language I – III“ to meet the requirements of the module “Additional Key Skills”. In exceptional cases, the board of examiners shall decide on what type of achievement shall be acceptable.

Section 15 Subject-specific requirements for admission to the master’s thesis

Students may only be admitted to the master’s thesis after having gained a minimum of 83 CP from modules completed as part of the master programme.

II. Final provisions

Section 16 Effective date

(1) These Study and Examination Regulations shall take effect in the winter semester 2010/11. They shall be published in the Official Bulletin (“Amtliche Bekanntmachungen”) of Ulm University. The Subject-Specific Study and Examination Regulations for the English language master programme “Advanced Materials” offered by the Faculties of Natural Sciences, Engineering and Computer Science and Medicine of Ulm University of 1 July 2008, published in the Official Bulletin (“Amtliche Bekanntmachungen”) of Ulm University, no. 15 of 10 July 2008, shall cease to have effect subject to paragraph 2 below.

(2) Students who are enrolled, in the winter semester 2010/11, in a higher subject-specific semester than the first semester shall complete their studies under the Subject-Specific Study and Examination Regulations for the English language master programme “Advanced Materials” offered by the Faculties of Natural Sciences, Engineering and Computer Science and Medicine of Ulm University of 1 July 2008 .

Ulm, 8 July 2010

Prof. Dr. Karl Joachim Ebeling

President

ADVANCED MATERIALS **Curriculum Nanomaterials**

1st semester	CP	SWS	2nd semester	CP	SWS	3rd semester	CP	SWS	4th semester	CP	SWS
Materials Science I	10 CP	8 h	Materials Science II	10 CP	8 h						
Chemistry	8 CP	7 h	Chemistry	3 CP	2 h						
Physics	5 CP	4 h	Physics	4 CP	3 h						
Electrical Engineering	5 CP	4 h									
			Nanomaterials I	8	6 h	Nanomaterials I	13 CP	10 h			
			Elective Courses in Nano- / Biomaterials	7 CP	8 h	Elective Courses in Nano- / Biomaterials	9 CP	10 h			
German Language I	3 CP	4 h	German Language II	3 CP	4 h	German Language III	2 CP	2 h			
									Master Thesis	30 CP	40 h
Sum Compulsories	31 CP	# h		28 CP	23 h		15 CP	12 h		30 CP	40 h
Sum Comp. & Elect.	31 CP	# h		35 CP	31 h		24 CP	22 h		30 CP	40 h

Offered Elective Courses 2nd sem.

Basics of TEM
Cell Interactions with Biomaterials and Imaging Techniques
Colloids
Compound semiconductors
Mechanics of Materials
Micro- and Nanostructured Optics
Sensors and Actuators

Offered Elective Courses 3rd sem.

Applications of TEM
Biosensors
Cell Mechanics and Interactions with Biomaterials
Exploring the Nanoworld with X-Rays & High Energy Electrons
Innovation Management for Nanotechnology
Laser, Laser-Matter Interactions
Materials in Cell and Tissue
Physics of Scattering
Polymers in Medicine
Surface Plasmon Photonics
Theory in Polymer Physics
Thin Films

ADVANCED MATERIALS **Curriculum Biomaterials**

1st semester	CP	SWS	2nd semester	CP	SWS	3rd semester	CP	SWS	4th semester	CP	SWS
Materials Science I	10 CP	8 h	Materials Science II	10 CP	8 h						
Chemistry	8 CP	7 h	Chemistry	3 CP	2 h						
Physics	5 CP	4 h	Physics	4 CP	3 h						
Biology and Cell Biology	5 CP	4 h									
			Biomaterials I	5 CP	4 h	Biomaterials II	8 CP	7 h			
			Elective Courses in Nano- / Biomaterials	11 CP	4 h	Elective Courses in Nano- / Biomaterials	13 CP	7 h			
German Language I	3 CP	4 h	German Language II	3 CP	4 h	German Language III	2 CP	2 h			
									Master Thesis	30 CP	40 h

Sum Compulsories	31 CP	27 h	25 CP	18 h	10 CP	10 h	30 CP	40 h		
Sum Comp. & Elect.	31 CP	27 h	36 CP	22 h	23 CP	17 h	30 CP	40 h		

Offered Elective Courses 2nd sem.	Offered Elective Courses 3rd sem.
Basics of TEM	Applications of TEM
Cell Interactions with Biomaterials and Imaging Techniques	Biosensors
Colloids	Cell Mechanics and Interactions with Biomaterials
Compound semiconductors	Exploring the Nanoworld with X-Rays & High Energy Electrons
Mechanics of Materials	Innovation Management for Nanotechnology
Micro- and Nanostructured Optics	Laser, Laser-Matter Interactions
Sensors and Actuators	Materials in Cell and Tissue
	Physics of Scattering
	Polymers in Medicine
	Surface Plasmon Photonics
	Theory in Polymer Physics
	Thin Films